

28
CLAIMS

We claim:

1. A method for embedding a watermark into content, said content containing content samples, comprising the steps of:
 - (a) receiving said content;
 - (b) creating a continuous watermark sequence from said watermark;
 - (c) for each content sample in a first predetermined order:
 - (i) calculating a sample mean;
 - (ii) calculating a sample variance; and
 - (iii) normalizing said content;
 - (d) generating a set of content coefficients from said content;
 - (e) generating a set of watermark coefficients from said watermark sequence;
 - (f) embedding said watermark in said content by adjusting the amplitude of said watermark coefficients so that the distortion between the content coefficients and the associated watermark coefficients are minimized using a secret mapping function; and
 - (g) outputting said content.
2. The method according to claim 1 wherein said step of embedding said watermark in said content is performed by adjusting the watermark coefficients sequentially in a second predetermined order.
3. The method according to claim 1 wherein said digital content is an image and said content sample is a pixel.

- 1 4. The method according to claim 1 wherein said secret mapping function has
2 parameters, and said parameters are controlled by one or more key-dependent
3 sequences.
 - 1 5. The method according to claim 4 wherein said key-dependent sequences are key-
2 dependent random sequences.
 - 1 6. The method according to claim 4 wherein at least one of said key-dependent
2 sequences are uniformly distributed.
 - 1 7. The method according to claim 4 wherein at least one of said key-dependent
2 sequences is continuous.
 - 1 8. The method according to claim 4 wherein at least one of said key-dependent
2 sequences is secret.
 - 1 9. The method according to claim 1 wherein each watermark coefficient may have a
2 different quantization step size.
 - 1 10. The method according to claim 1 wherein said secret mapping function is a
2 sawtoothed function.
 - 1 11. The method according to claim 1 wherein said secret mapping function is a triangle
2 mapping function.

- 1 12. The method according to claim 1 wherein said secret mapping function is a binary
2 function using randomized quantization steps.
 - 1 13. The method according to claim 1 wherein said secret mapping function is generated by
2 a program.
 - 1 14. The method according to claim 1 wherein said secret mapping function is continuous.
 - 1 15. The method according to claim 1 wherein said secret mapping function is piecewise
2 continuous.
 - 1 16. The method according to claim 1 wherein said secret mapping function is a look-up
2 table.
 - 1 17. The method according to claim 1 wherein said secret mapping function is a pixel
2 based function.
 - 1 18. The method according to claim 1 wherein said first predetermined order is a raster
2 scan order.
 - 1 19. The method according to claim 2 wherein said second predetermined order is a zig-zag
2 order.
 - 1 20. A method for extracting a watermark sequence from watermarked content comprising
2 the steps of:

- 3 (a) receiving watermarked content comprising received coefficients;
- 4 (b) generating an estimated watermark determined by received coefficients, and a
- 5 mapping function;
- 6 (c) generating a watermark sequence using a correlation function, said correlation
- 7 function using the watermarked content, the estimated watermark, a scaling
- 8 factor, and a weighting factor per a predetermined equation; and
- 9 (d) outputting the watermark sequence.

1 21. An apparatus for extracting a watermark sequence from watermarked content
2 comprising:

- 3 (a) a noise source;
- 4 (b) a key dependent sequencer;
- 5 (c) a mapping function having parameters, at least one of said parameters
- 6 receiving input from said key dependent sequencer;
- 7 (d) a watermark estimator, said watermark estimator generating a watermark
- 8 estimate from the watermarked content, and the mapping function.
- 9 (e) a scale factor;
- 10 (f) a weight factor; and
- 11 (g) a correlator, said correlator generating the watermark sequence from the
- 12 watermarked content, the scale factor, the weight factor and the watermark
- 13 estimate.

1 22. An apparatus for embedding a watermark data into content including:

- 2 (a) a content preprocessor, said content preprocessor further including:
- 3 (i) a mean calculator; and

- 4 (ii) a variance calculator;
- 5 (b) a content coefficient generator for generating content coefficients from the
- 6 preprocessed content;
- 7 (c) a watermark sequence generator for generating a watermark sequence from the
- 8 watermark data;
- 9 (d) a watermark coefficient generator for generating watermark coefficients from
- 10 the watermark sequence; and
- 11 (e) a watermark inserter for generating watermarked content.

1 23. An apparatus according to claim 22, wherein said watermark inserter further includes:

- 2 (a) a key dependent sequencer;
- 3 (b) a secret mapping function device, said secret mapping function device
- 4 receiving input from said key dependent sequencer; and
- 5 (c) a coefficient modifier for generating watermarked content by adjusting the
- 6 amplitude of the watermark coefficients so that the distortion between the
- 7 content coefficients and the associated watermark coefficients are minimized
- 8 using the secret mapping function device.